

TOSS-UP

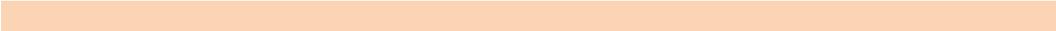
1) Earth and Space — *Short Answer* What is the term for a basin created by the collapse of a magma chamber?

ANSWER: CALDERA

BONUS

1) Earth and Space — *Short Answer* What compositional layer of Earth has the steepest geothermal gradient?

ANSWER: CRUST (do not accept: LITHOSPHERE)



TOSS-UP

2) Energy — *Multiple Choice* Scientists at Lawrence Berkeley National Lab are studying protists that consume bacteria and have pseudopodia. What taxonomic group are these protists part of?

- W) Apicomplexa
- X) Amoebozoa
- Y) Porifera
- Z) Ciliata

ANSWER: X) AMOEBOZOA

BONUS

2) Energy — *Short Answer* Scientists at Fermilab are designing a neutrino detector that will use 592 kilograms of heavy water. To three significant figures, how many moles of heavy water will they need?

ANSWER: 29,600

TOSS-UP

3) Math — *Short Answer* Two sides of a triangle have lengths 8 and 17. What is the largest possible area of the triangle?

ANSWER: 68

BONUS

3) Math — *Short Answer* Starting with a cube, one dimension is increased by 4, another is decreased by 4, and the other is left unchanged. If the new solid has a volume 96 less than that of the original cube, what was the volume of the original cube?

ANSWER: 216

TOSS-UP

4) Physics — *Short Answer* Identify all of the following three physical quantities that can be measured in kilogram-meters per second: 1) Energy; 2) Momentum; 3) Impulse.

ANSWER: 2, 3

BONUS

4) Physics — *Short Answer* A spherical exoplanet has the same surface gravity as Earth, but has four times Earth's diameter. What is the ratio of the mass of this exoplanet to the mass of Earth?

ANSWER: 16 (ACCEPT: 16 TO 1)

TOSS-UP

5) Biology — *Multiple Choice* Which of the following genetic disorders is caused by an aneuploidy of the sex chromosomes?

- W) Cystic fibrosis
- X) Down syndrome
- Y) Sickle cell disease
- Z) Turner syndrome

ANSWER: Z) TURNER SYNDROME

BONUS

5) Biology — *Short Answer* Identify all of the following three statements that can be assumed to be true of a population in genetic equilibrium: 1) The larger the population, the smaller the impact of genetic drift; 2) Mating is random; 3) Allele frequencies are changing.

ANSWER: 1, 2



TOSS-UP

6) Chemistry — *Multiple Choice* Which of the following molecules is classified as an arene [*AIR-eeen*]?

- W) Cyclohexane [*sigh-kloh-HEX-ane*]
- X) 1,3-butadiene [*one three byoo-tah-DYE-eeen*]
- Y) Hexene
- Z) Benzene

ANSWER: Z) BENZENE

BONUS

6) Chemistry — *Short Answer* Identify all of the following three molecules that typically act as nucleophiles: 1) Hydroxide; 2) Cyanide; 3) Ammonia.

ANSWER: ALL

TOSS-UP

7) Earth and Space — *Multiple Choice* Which of the following colors of light will have the shallowest penetration in the marine water column?

- W) Red
- X) Yellow
- Y) Blue
- Z) Violet

ANSWER: W) RED

BONUS

7) Earth and Space — *Multiple Choice* Which of the following best describes the tectonic location of a passive continental margin?

- W) At a convergent boundary
- X) At a divergent boundary
- Y) At a transform boundary
- Z) At the plate interior

ANSWER: Z) AT THE PLATE INTERIOR

TOSS-UP

8) Energy — *Multiple Choice* Scientists at SLAC National Accelerator Laboratory are studying tetraquark particles, which have four constituent quarks. How many constituent quarks does a baryon have?

- W) 1
- X) 2
- Y) 3
- Z) 4

ANSWER: Y) 3

BONUS

8) Energy — *Multiple Choice* Oak Ridge National Lab scientists are using the Spallation Neutrons and Pressure Diffractometer to collect diffraction data under pressure conditions as high as 120 gigapascals. Which of the following is closest to the number of atmospheres that these pressures are equivalent to?

- W) 1 hundred
- X) 1 thousand
- Y) 1 million
- Z) 1 billion

ANSWER: Y) 1 MILLION

TOSS-UP

9) Math — *Multiple Choice* Consider a cubic polynomial whose coefficients sum to zero. Which of the following must be a zero of this polynomial?

- W) -1
- X) 0
- Y) 1
- Z) 2

ANSWER: Y) 1

BONUS

9) Math — *Short Answer* What are the coordinates of the vertex of the graph of $y = -3x^2 - 24x - 23$?

ANSWER: $(-4, 25)$ (ACCEPT: $x = -4$ AND $y = 25$)

TOSS-UP

10) Physics — *Multiple Choice* When a wave passes into a new medium, the sudden change in which of the following properties of the wave is responsible for causing refraction?

- W) Speed
- X) Frequency
- Y) Amplitude
- Z) Polarization [*polar-eye-ZAY-shun*]

ANSWER: W) SPEED

BONUS

10) Physics — *Short Answer* Identify all of the following three ideal systems that exhibit simple harmonic motion: 1) Spring-mass system; 2) Small-angle pendulum; 3) Mass in freefall.

ANSWER: 1, 2



TOSS-UP

11) Biology — *Multiple Choice* Which of the following planes splits the human body into right and left halves?

- W) Sagittal
- X) Transverse
- Y) Frontal
- Z) Coronal

ANSWER: W) SAGITTAL

BONUS

11) Biology — *Multiple Choice* In which of the following aquatic ecosystems would you expect dissolved oxygen concentrations to be so high that they are supersaturated with respect to the atmosphere?

- W) A nutrient-rich, eutrophic lake
- X) Ocean bathypelagic [*bath-ih-pah-LAJ-ik*] zone
- Y) A dystrophic lake
- Z) An oligotrophic [*AW-lig-oh-troh-fik*] lake

ANSWER: Z) AN OLIGOTROPHIC LAKE

TOSS-UP

12) Chemistry — *Short Answer* What is the adjective for a covalent bond in which both shared electrons originate from the same atom?

ANSWER: DATIVE (ACCEPT: COORDINATE)

BONUS

12) Chemistry — *Short Answer* In many lyotropic [*lye-ah-tropic*] liquid crystals, the rod-shaped structures are aggregates of spherical substructures that have hydrophobic tails directed inward and hydrophilic heads directed outward. What is the term for these substructures?

ANSWER: MICELLES

TOSS-UP

13) Earth and Space — *Short Answer* The solar wind is a stream of particles released from what layer of the Sun?

ANSWER: CORONA

BONUS

13) Earth and Space — *Multiple Choice* At which of the following times does a first-quarter moon rise above the horizon?

- W) Midnight
- X) Sunrise
- Y) Noon
- Z) Sunset

ANSWER: Y) NOON

TOSS-UP

14) Energy — *Short Answer* Researchers at Brookhaven National Lab are using DNA origami. In DNA origami, how many hydrogen bonds are formed between thymine [**THIGH-meem**] and adenine [**AD-eh-noon**]?

ANSWER: 2

BONUS

14) Energy — *Short Answer* Scientists at Lawrence Berkeley National Lab are studying magnetic polarization [**polar-eye-ZAY-shun**] in protoplanets. They hypothesize that the polarization occurred due to an external magnetic field produced by a rotating protoplanetary core. What theory describes this mechanism of magnetic field generation?

ANSWER: DYNAMO THEORY (ACCEPT: GEODYNAMIC MAGNETISM, DYNAMO EFFECT)

TOSS-UP

15) Math — *Multiple Choice* Which of the following cannot be the number of vertices of a Platonic solid?

- W) 4
- X) 8
- Y) 12
- Z) 16

ANSWER: Z) 16

BONUS

15) Math — *Short Answer* What is the cosine of the smallest angle in a triangle with side lengths of 5, 7, and 8?

ANSWER: 11/14

TOSS-UP

16) Physics — *Short Answer* The intensity of a sound is directly proportional to what power of distance from the source?

ANSWER: NEGATIVE TWO

BONUS

16) Physics — *Short Answer* Rank the following three interfaces in order of increasing coefficient of static friction: 1) Teflon-teflon; 2) Ice-ice; 3) Steel-steel.

ANSWER: 1, 2, 3

TOSS-UP

17) Biology — *Short Answer* In a chicken egg, what membrane prevents water loss to the environment by forming a membrane just under the eggshell?

ANSWER: CHORION (ACCEPT: CHORIOALLANTOIC, CHORIOALLANTOIS)

BONUS

17) Biology — *Multiple Choice* A flower is purple in color, contains no nectar, and has an irregular shape. Which of the following is the most likely pollinator of this plant?

- W) Butterfly
- X) Bee
- Y) Bat
- Z) Flesh fly

ANSWER: Z) FLESH FLY

TOSS-UP

18) Chemistry — *Multiple Choice* Which of the following best describes a thermoset polymer?

- W) A polymeric [*paw-lih-MARE-ik*] material that can be reshaped after heating
- X) A polymeric material containing many different molecules bound together by intermolecular forces
- Y) A polymeric material that is generally lower in strength than thermoplastics
- Z) A polymeric material that consists of a single, highly cross-linked molecule

ANSWER: Z) A POLYMERIC MATERIAL THAT CONSISTS OF A SINGLE, HIGHLY CROSS-LINKED MOLECULE

BONUS

18) Chemistry — *Short Answer* Rank the following three elements in order of increasing atomic radius: 1) Cesium; 2) Barium; 3) Sodium.

ANSWER: 3, 2, 1